

House flies and stable flies are not only a nuisance on livestock and poultry farms, but they also transport disease-causing organisms. Certain native parasitic wasps are used as biological control agents of fly populations, reducing use of insecticides while saving farmers time and money.

To give farmers even more options, scientists in the ARS Mosquito and Fly Research Unit in Gainesville, Florida, have collaborated with scientists at the University of Campinas in Brazil for about 2 years to evaluate exotic wasp species that

may complement the native species in controlling pest flies.

Currently, farmers can buy native parasitic wasps, such as *Muscidifurax raptor*, *Spalangia endius*, and *S. cameroni*, from commercial insectaries. These wasps emerge into adulthood from the pupal stage, where they develop wings.

They fly from the release stations in which they have been held, hung from barn ceilings or other out-of-reach places and away from rodents looking for a savory meal. Female wasps swoop down onto the farm in search of their prey. They are single-minded; they choose only muscoid flies on which to feed and release their progeny.

Attacking Flies With Wasps



***Mucidifurax raptor* wasp on a fly puparium. Once the female chooses a suitable puparium host, she lays a single egg in it. The egg hatches, and the wasp larva feeds on the fly pupa.**



***Tachinaephagus zealandicus* wasp (male shown here), a promising parasitoid for fly control. Females of this species, common in the southern hemisphere, lay eggs inside fly larvae. Photo by Eric Erbe. Digital colorization by Chris Pooley.**

The parasitic wasps (also known as parasitoids) target only flies in their pupal stage, in which a layer of skin remaining from the fly’s larval stage hardens and forms a protective case known as a puparium. When the wasp finds a pupa in soil or litter, she inserts her stinger and withdraws it, drawing blood and paralyzing the pupa. After she ingests some blood, she might allow the stingerless male to feed. If the sting doesn’t eventually kill the pupa, the feeding will. If the female wasp decides the pupa would make a suitable host for her progeny, she inserts one egg into the air space under the puparium. The egg hatches after 1 day, and the larva feeds on body fluids and organs for 2 to 4 weeks. Eventually, the wasp chews its way out of the dead host’s puparium and flies away as an adult.

New Threats

As if farm flies didn’t have enough to worry about with these American-bred wasps, a new threat has emerged from south of the border. One such species, *Tachinaephagus zealandicus*, attacks flies earlier, while they are still in the larval, or maggot, stage. *T. zealandicus* has a mode of operation different than that of native parasitoids. Not only does the female lay multiple eggs in the maggot, she lays them inside its body cavity. Her eggs hatch after 1 day, but they leave their prey alive as they slowly devour it from the inside out, saving the brain and eyes for last. Their host actually continues to metamorphose—almost into adulthood—before it succumbs.

Despite being native to South America, *T. zealandicus* does not thrive in the hot summer months. ARS entomologist Christopher J. Geden says these wasps do not perform as well when the temperature gets in the mid or upper 90s. But they could be used in cooler months in the South or all summer in northern states.

Unlike their native counterparts, these adult exotic wasps do not derive energy from feeding off their fly hosts, according to Geden. Whereas natives must feed to develop their eggs, *T. zealandicus* wasps have eggs when they emerge from the fly puparium as adult females. But they don't have energy remaining for future attacks after they lay the eggs in a host.

The researchers found that feeding honey to the wasps replenished that energy. The strategy caused a threefold increase in the attack rate on target flies and increased the number of progeny developing inside flies. And when native wasps were fed honey for 2 to 3 days, they became more aggressive and long-lived than those given only pupae in insectaries.

Aggressor Becomes the Victim

Parasitoid wasps are vulnerable themselves to nature's cruel forces and are sometimes infected with a microsporidium in the genus *Nosema*. Infected wasps take longer to develop into adults and then lay far more male eggs. This is bad news for commercial insectaries, because only female wasps attack.

The Gainesville and Brazilian researchers also discovered in 1999 a new *Nosema* disease infecting *T. zealandicus*. Geden says the disease is transmitted from females to their offspring and is spread among wasp larvae when they share the same fly host.

"A drug test showed us that transmission from mothers to progeny can be interrupted by feeding the mothers honey treated with the antibiotic rifampicin," Geden says. "After treatment, a clean colony was established from family lines of uninfected females. Because they don't crave honey—though they will eat it—native wasps are harder to treat for *Nosema* disease."

Separated at Birth

Different species of parasitic wasps look so similar that telling them apart can be difficult. If species get mixed up in



House fly puparia, each with a hole from which a single wasp emerged after feeding on the pupa. Feeding occurs in the larval stage, and the wasp eventually emerges as an adult.

rearing factories, it can damage or ruin a whole program. ARS chemist David A. Carlson, in the Gainesville unit, applied a method known as gas chromatography to identify them by chemical analysis of the waxes wasps use to waterproof themselves. The waxes, known as cuticular hydrocarbons, may also be used in mate recognition. A hexane solvent removes the wax components from the exoskeleton, and a tiny sample is vaporized and its properties analyzed. They found reliable

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differences on cuticular hydrocarbons on four closely related species of parasitoids.

T. zealandicus is currently being evaluated for use in muscoid fly control. The wasp doesn't sting people or livestock. Although it is under quarantine, Geden says it has made it into the United States before and does not appear to be any kind of threat if released.

"Ideally, we would like to see *T. zealandicus* used in natural biological control," Geden says. "After thorough testing, we have more work to do to ensure there are no undesirable nontarget effects, meaning it doesn't attack beneficial insects. If everything works out, we would seek permission to use this species to control muscoid flies."—By **Jim Core**, ARS.

This research is part of Arthropod Pests of Animals and Humans, an ARS National Program (#104) described on the World Wide Web at <http://www.nps.ars.usda.gov>.

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